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CROP ECOLOGY AND THE PRIMARY VEGETATIONAL SURVEY.*

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At a meeting of Agricultural Experiment Station workers, it seems fitting to quote a statement made at the British Association meeting recently by the Director of Rothamstead, (8). In discussing the organization of the experiment stations to meet the problems of crop production and the complexity of the results furnished by various members of the staffs, he asks, "What is the purpose of it all? Team-work, co-operation, the great expenditure of time and money now being incurred in agricultural science and experiment, these are justified only if the end is worthy of the effort. The nineteenth century took the view that agricultural science was justified only in so far as it was useful. That view we now believe to be too narrow. The practical purpose is of course essential; the station must help the farmer in his daily difficulties—which again necessitates co-operation, this time between the practical grower and the scientific worker. But history has shown that institutions and investigations that tie themselves down to purely practical problems do not get very far."

A bird's eye perspective of the work at experiment stations all over the country seems to indicate that a number of them are offering the daily bread of empiricism without much scientific jam on it to meet the daily difficulty. A number of them and fortunately an increasing number each year devote their best talent to the investigation of fundamental problems. It is my purpose to try to sketch some of the fundamental problems of crop ecology, not so much pointing out specific problems, but instead attempting to outline them.

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Remembering the great scope and tremendous complexity of the problems which the agriculturalists must face, we can put up a defence without shame for the use of some empirical methods of attacking these problems. If by empiricism be meant a trial and error method we cannot reject it altogether in spite of its cumbersomeness and expense, for a strictly logical method of attack. The reason is plain enough. There are so many unknown quantities in all biological phenomena. The mathematician has the advantage of assuming certain conditions and handling his unknown quantities piece-meal. The agriculturalist must face his unknowns all massed within the living plant. He is forced to make deductions from experiments which he may find impossible to duplicate exactly. He must therefore expect to get his best results from a combination of empirical and scientific methods.

How, you may ask, does this relate to any of the problems of crop ecology? In its broadest sense this would include all of the problems of agriculture as we are now facing them, both to meet the present difficulties of a practical grower and the broad general needs of the people of our State of Ohio. If all the problems which we face could be massed into one, we would instantly perceive that crop ecology is the central scientific basis upon which to build and that the keystone problem is *adaptation*.

Now by adaption in our crop plants we do not necessarily have in mind the same kinds of adjustments merely that we have in the native and naturalized plants of a region. It is sufficient for the native plants that they are not killed in the winter or burned by the summer's drouth, that the soil supplies the water and minerals needed, that their enemies are not so numerous or so persistent that they cannot outgrow them, that they ripen seeds or store food in vegetative organs. In perennials it is not even necessary to ripen seeds each year. In our crop plants on the other hand, not only must the plant produce some desired product, but this yield must be produced in a given season and must be of a marketable quality if the plants are to return a profit to the grower. The highest yielding wheats are not always the most desirable. Milling and baking tests must be made to show whether the plant is suited to consumers demands as well as the growers' interests. A dwarfed timothy plant would be a menace if it also happened

to produce seeds very abundantly. A common barberry bush of any color is accursed. Flax and hemp, formerly acceptable and suited to both the soils and climate of the state have practically disappeared. Clover failure presents an acute farm problem in our older agricultural sections. All of these instances indicate that we must look to the kind of product and to its quality before determining whether or not our crop plants are adapted. The work of the plant breeder and of the ecologist must be co-ordinated. We can expect permanent advances in our agricultural position only in proportion to the amount of linked effort that is made.

Briefly, we have variables in the plant and in its surroundings. In both the interior of the plant and in its environment we are, within limits, able to exercise some control. We call the facts relating to the interior of cells of plants its heredity and we hide our ignorance of the way these inherited characteristics may descend from one generation to another in the terminology of genetics. We classify the groups of factors that surround the plant and modify the expression of its heredity as climatic, edaphic and biotic, and we are led away by some words into thinking that our case can rest. But we often fail to synthesize observations and experiments made in these groups of facts and apply them. Here is where our true problem of adaptation comes in and where the ecology of our crops will find its real phase of usefulness—interpreting the results, because of the methods of analysis.

Let me take an example, from our agricultural history, of an empirical method of meeting a pressing need. Cotton was reported in 1789 to be growing successfully at Marietta. Moreover, the colony had some surplus product which was advertised for sale in Paris. Cotton was grown until 1840 as one of the crops of Lawrence County. While no one could now think of growing cotton in Ohio, starting with the seeds of the plants at the present time grown in Southern States, who knows but that we lost a most valuable agricultural plant by failing to maintain an interest in what is a most unique phase of a great industry. The empirical method led to a valuable result, but after commercial contact between the states was on a firmer footing the pioneer industry died away for lack of interest.

Rice also was grown by the Marietta pioneers, but it seemed less promising and certainly was less needed than cotton.

It might be mentioned in passing that a native industry in growing our wild rice grass may yet offer possibilities, since it has already been introduced into some markets as a variant in our diets. Mention is made of this to show that while the pioneers practiced their own empiricisms, they were not willing to learn from the experience of the Indians the use of native plants.

In contrast to this type of empirical method let us consider another. This has to do with a distributional problem in which but one factor in the environment of the plants was employed as a means of showing graphically plant distribution. This factor is one that is directly related to growth, but is not so directly related to geographic distribution. The scheme proposed by the directors of the biological survey is the one which employed only the single factor, temperature, to indicate plant and animal distribution. Within a short while after it was proposed, a number of ecologists, Adams, Shelford, Cowles and Transeau among them, pointed out its fallacy. However, it has not stopped the Survey from using its own method, nor a great many people from employing terminology used at that time. The principal paper on the subject was by Dr. C. Hart Merriam (7) and called "Life Zones and Crop Zones." In one section called "Laws of temperature control of geographic distribution of animals and plants," it is stated that temperature is the most important single factor, apart from mechanical barriers, in fixing the limits beyond which certain species cannot go. The United States is divided into a series of zones with bands running east and west and named, Boreal, Transition, Upper Austral, Lower Austral, Gulf strip of the Lower Austral, and Tropical. These zones are obtained along the isotherms made by connecting, on a large map of the U. S., the stations where the sums of the positive temperatures are the same during the season when the mean daily temperature is about 60 c. No accounting for moisture is allowed, though the plan divides the Eastern half of the United States into a region called humid, and the Western half, while not designated, is presumably arid, with no account taken of the region of highest rainfall in the United States, on the Northwestern Coast. It is most remarkable that this should have obtained much credence with biologists in North America. Not only is it still reported in all the biological survey publications, but even some of our

Canadian Naturalists have made use of the terminology as late as the current year. Lloyd in a paper on the vegegation of Canada has continued to use the terminology with the plea that it is well known. Unfortunately its fault of being based on a single factor of the environment is not well enough known. What does it lead us to? To take the zone designated as Upper Austral as an example, it embraces the Atlantic Coast from Connecticut to the Potomac River; the Western, but not the Eastern half of Long Island, the Hudson River Valley; it extends Southwest from Maryland to Alabama and West to Northeastern Montana, nearly to the Canadian border and south through the Mexican State of Durango. It would lump together such distinctive types of vegetation as our Eastern deciduous forests, the prairies, the plains, and some of the semi-arid regions in New Mexico and Mexico. The Lower Austral includes the coast of Virginia, the Mississippi Valley on the Western boundary of Kentucky and Lower California. The species or the groups of species in these regions are certainly not closely related to each other. With the crop plants such an unfortunate attempt to bolster up misapprehension of the fact appears as in the statement, "that while corn is no exception to the fact that cereals thrive best in cool climates, most of the varieties are found in the lower Austral zone."

Is it any wonder then that with the impetus that has been given to the promulgation of this particular misconception that the Experiment Stations have not taken into serious account of the work of those of the ecologists whose ideas of the distribution of plants and animals have been more conservatively formed and offered with some reserve and many exceptions pointed out as to geographic detail?

In order to study distribution it is necessary to take some measure to account of all of the factors of the environment. There is no empiricism about this. It is simply a record of observation. And as the record is a long one many conservative ecologists—notably Tansley, Cowles and others still emphasize the need of more descriptive ecology. This does not mean a mere listing of the plants in a given area, but a definite attempt to show the relations existing between environmental factors and the development of a particular association of plants. There is no definite border line between the best type of descriptive ecology and the beginning of experimental ecology.

For in the end experimental ecology is the interpretation of scientific observation.

Much better schemes than Merriam's for showing graphically the underlying causal factors of the geographic distribution of vegetation and of animal life have been worked out. They all employ combinations of factors instead of a single factor. Among such are Livingston's Moisture—Temperature charts and Shreve's ratio of soil moisture to evaporation and Transeau's Rainfall-Evaporation chart, (10). Livingston and Shreve (5) in discussing the Rainfall-Evaporation chart state: "The importance of the moisture ratio in controlling the leading vegetations was shown by Transeau for the Eastern United States, and our investigation has served to confirm his deductions as well as to extend their application to the entire country. The comparisons which have been made between the vegetational areas and the various other climatic conditions have served to emphasize the moisture ratio even more than was done by Transeau, since no other single datum has been found in our work to approach it as an expression of the controlling conditions for forest, grassland and desert."

Long ago Asa Gray called plants the thermometers of the ages. That is still a good statement. One of the ways in which we can apply the accumulating knowledge of the distribution of vegetation and the physical factors which underlie this distribution is in mapping out the distribution of our crop plants. The familiar work of Shantz on the indicator significance as to the capabilities of land for crop production represents an appreciation of the fact that a living plant growing in a particular habitat is often the most accurate way of measuring the environment. Clements (2) work on Plant Indicators is of much value for reference and research, especially being a record of observations in the Western sections of the United States.

A classic example of the correlation of the work of several ecologists who have studied a single region is to be found in a series of papers by Kincer (4), Marbut (6), Shantz (9) and Baker (1) on the Great Plains. These authors respectively discuss the climate, soils, vegetation and types of farming of the Great Plains region. As is to be expected, there are marked correlations to be found between the physical factors of the environment, the vegetation, and the crop plants that can be grown. It represents a wonderful Synthetic study of a region that should be duplicated for the various sections of the country

as a primary survey undertaken before making permanent or radical changes in an already existing system of agriculture Shantz divides the Plains into four sections as follows:

A. Land primarily valuable for crop production. In this section needle grass and slender wheat grass are indicators of the possibilities for spring wheat and the spring cereals; Bluestem bunch-grass indicating winter wheat, corn and alfalfa and mesquite and mesquite grass indicating cotton and grain sorghums.

B. Land valuable for crop production and grazing with crop failure when the rainfall is less than normal. Grama and western needle grass indicate spring wheat and other spring grain; wire grass indicates winter wheat, corn, and in the south the grain sorghums; wheat grass indicates spring grains and corn; and grama and mountain sage indicates spring grains.

C. Land valuable for grazing and crop production; good crops only during years of more than normal rainfall. Grama and buffalo grass indicate grain sorghums corn and small grains. Mesquite grass and thorn bush indicate cotton and grain sorghums during good years only. Sand sage and sand grass indicate corn and sorghum except in the southwest and grams grass indicates spring grains during the good years.

D. Land valuable for grazing only is indicated by sagebush, western wheat grass and Blackgrama.

Baker points out that often settlers unacquainted with the nature of the region try the wrong types of farming, and that sixteen hundred acres often can produce no more than 160 acres in the Eastern States. Marbut shows the importance of an examination of a soil profile so that the underlying soil as well as the topmost layer may be used to indicate the kinds of plants that may be grown.

Putting it briefly, we seem to be justified in making a strong case for the dynamic role played by the plants. For the climatic conditions are not varying, the soil not greatly varying. The extremes in the distribution of rainfall over a period of many years, not the seasonal rainfall, determine the native vegetation and the humus has largely determined the soil conditions. Some years ago the writer (11) made use of the *E* ratio of Transeau to show graphically the general features of the distribution of our crop plants. It is very gratifying to see that the detailed studies of the Great Plains discussed above bear out in the main the location of crop centers as deduced from a study of the rainfall evaporation ratio.

In the Eastern part of the United States with a higher content of soil moisture, the evaporation rate has been shown by a number of ecologists to be correlated with distribution. Of the greatest interest is the growth of our crop plants under field conditions with a daily record of the water loss. This has not been used as yet to the extent of its possibilities in indicating the correlations between moisture and yields.

Following the work of Garner (3) and Allard, light, too, must come into an added place of importance from the standpoint of photoperiodism. The older work has long recognized light intensity in relation to photosynthesis, and light intensities in relation to transpiration, by which it is tied up in a complicated way with both moisture and temperature factors. The new point calls attention to the direct effect of the length of the day. The significance has already been pointed out with a number of crop plants. Thatcher at the Ohio Station found that the planting dates of wheat vary somewhat with the latitude. Wanser has stated that photoperiodism is the key to the distinction between spring and winter wheats. Adams has shown that in both wheat and rye light, is, with heat in the greenhouse, important in controlling the date of heading out of the different varieties. For the explanation of spring and winter cereals we must look to an inherent rhythm in the plants adjusted to the peculiar Mediterraeann climate where these plants have long been grown. In the Mediterranean type of climate we may observe two cool moist growing seasons, the spring and autumn. There are also two dormant periods, the hot summer, too dry for plant growth, and the moist winter, too cool for plant growth. Winter wheat and rye have swung into this rhythm by growing in the fall and spring—the short day periods, and blooming in long day periods of early summer. Spring wheat lacking the autumn vegetative period has its vegetative activity telescoped and has consequently stored a less quantity of carbohydrates before blooming. Corn, on the other hand, represents a short day reproductive type. It has been modified by years of selection by the American Indian in carrying it northward from central America until there are some varieties which begin blooming a few weeks after the summer solstice. In winter time in the greenhouse we can have corn blooming in from five to seven weeks after it has been planted. Some selections of early blooming varieties of corn have been made at the Ohio Experiment Station. Potatoes show the same

response to light periodicity in different latitudes. Halves of the same tubers which bloomed and set seed at Presque Isle, Maine, did not open any flowers at all in the New York Botanical Gardens.

Turning now to some of the biotic factors, the foresters know that certain groups of plants often do well when the same plants separated and grown in the open would not thrive. There is undoubtedly something gained by combining certain plants in attempting to obtain growth returns. Passing over the many varied explanations, let us look at certain suggestive experiments. At the Minnesota Station, Arny has recommended under certain conditions the combination of wheat and flax when the latter is grown for its seeds. At the Ohio Station there seem to be benefits under certain conditions resulting from combining corn and soy beans. Just as with the other factors studied there are a great many problems that need to be solved in the biotic groups as well as in the climatic and edaphic problems, all relating to adaptation. Other examples of biotic factors that have been studied in a very intensive way may be drawn from the many plant pests that produce crop yields. So definitely localized are many of the resistant varieties that in two parts of the country where the same crop may be grown, a variety found to be successful at one place is found to be perfectly worthless at the other. It seems in the interests of adaptation, therefore, that the wise plan for experiment stations over the country would be to carry on some interchange of their discards, (as in the game of rum), just as well as to exchange their more valuable selections.

One advance step that can be carried on by the co-operated activities of the Ohio Experiment Station and the University would be to undertake a complete primary survey of the vegetation of Ohio. In the State Herbarium are deposited many plants which are not any longer found in the counties in which they once were native. There are also records of the original surveys of the State in the State House and there is the group of field workers who have opportunity to make contributions to the ecology of Ohio by their observations in Forestry and Crops at the Station and at the University. It would mean much, not in any immediate practical way, but in a fundamental way, to the future development of the Agriculture of the State if all of this information could be compiled and

edited and serve as the basis for recommendations as to future experimental work and also a good basis for practice. Local botanists with training in field work could co-operate with the staffs of the Experiment Station and the University to their mutual advantage. Thus with the formation of a central committee, a plan for mapping the vegetation of the entire State should be proposed. The types of vegetation already studied and the mapped areas should be examined and so furnish suggestions for proceeding with the art of the work. For we will only be able to formulate problems in general ecology and in our crop ecology after we have mapped definitely the vegetation of our area, as the first requisite is a certain number of accurately observed and recorded facts. The floristis studies made a quarter of a century and more ago will not suffice. The problems there were of discovering species, but now they consist of evaluating the physical factors that control the grouping of plants into associations.

If the work of such a committee as outlined were carried out, Ohio would be taking a step forward that would not only contribute to a knowledge of the vegetation of the world. This survey, when combined with our knowledge of physiology, pathology and genetics would offer the key to many of our most important problems of adaptation.

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A REVIEW OF THE GENUS ERISTALIS LATREILLE IN NORTH AMERICA.

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Introduction.

In many ways a treatment of the North American species of the genus *Eristalis* is much to be desired. This is especially true of certain groups of species, the separation of which have long perplexed students of the family. Several studies have been presented in the past, but these have treated of a limited number of forms. The Ohio State University collection is particularly rich in species of the genus and, at the suggestion of Professor J. S. Hine, the writer was led to take up the study of the group, a study that has been carried on intermittently over the last two years. Although opportunity was afforded to study good series of many forms known hitherto from but few specimens, the work is still necessarily incomplete. First, there remain a considerable number of species on the lists, not recognized since they were described, and secondly, although few species have been described in recent years, and few are offered here, there must undoubtedly be numerous forms in Central and South America that are as yet undiscovered. This is an obvious conclusion when we consider how little is known of the United States and compare the still more unknown regions southward. As many of the South American species as were avilable for study have been included in the paper, since extensive collecting in Central America seems certain to extend the range of numerous species. In some cases the inclusion of South American forms has enabled the writer to better characterize certain groups. For example, the *scutellaris* group contains but four North American species, to which, however, may be added at least four South American forms.

Something over two thousand specimens have been gathered together for study. While a great deal of material has been studied from the Ohio State University collections, considerable has been obtained from other sources. The writer has met with a generous response from other workers with respect to the

loan of material. These are too numerous to more than mention, but he wishes to express his thanks to the following gentlemen: C. W. Johnson, C. H. Curran, C. L. Fluke, W. M. Davidson, A. L. Lovett, R. C. Shannon, F. R. Cole, F. E. Lutz, C. B. Garrett J. M. Aldrich. He especially desires to express his appreciation to Professors J. S. Hine and R. C. Osburn, for advice and assistance of many kinds, as well as the loan of considerable material.

Treatment of the Species.

The writer presents a scheme of division of this large and unwieldy genus into a number of groups. Although the arrangement is not perfect, most of the groups are quite clearly defined, and this would seem to considerably facilitate classification. Naturally a few species overlap, are intermediate, or fall into more than one group, but such cases are few. Moreover, the grouping arrangement is strengthened when considered in the light of geographical distribution. While the existence of certain groups has always been more or less tacitly assumed, and various terms applied to them, their value has not been sufficiently appreciated, nor the ease and readiness with which species fall into them. While a few structural characters exist, these are comparatively few, and the groups may not be thus distinguished; they are discussed below. Indeed the new world forms seem to present a remarkable dearth of structural characters, in strong contrast to several old-world groups, notably of Africa. Returning to the question of geographical distribution, we may take, for example, the *albifrons* group, a distinctly neotropical division, limited to the neotropical region, and the southernmost borders of the United States. On the other hand, such heavily pilose species as *pilosus*, *flavipes*, *bastardi*, etc., comprise a typically holartic group, with many palaeartic members. Doubtless more extensive collecting will add more European and Asiatic species to the American fauna. One such species is added in the present paper. Lastly, we have the species of the *aeneus* group, with spotted eyes, etc., with a single North American member, and a large number of Oriental and Aethiopian forms.

A number of genera or subgenera have been split off from the genus at times, but generally based upon rather slender grounds. Such are *Eristalomyia*, including the species with

arista bare to pubescent, and eyes unicolorous. The forms with eyes spotted have been subdivided into *Lathyrophthalmus*, with holoptic males, and *Eristalinus* with dichoptic males, etc. *Eristalis* sens. str., finally containing those forms with plumose arista. I have disregarded such separations in the present paper, for a number of reasons. Between plumose and pubescent (or bare) aristæ, there is a great deal of variation. However, it will be found that in the main, such characters do, *in part*, characterize the groups here presented. The members of the *dimidiatus* group have the arista typically plumose, whereas in *latifrons* the arista is bare; but the latter species is quite obviously a member of the group mentioned. Again in the "bare-arista" forms of the *albifrons* group, we have a markedly plumose species, *transversus*. The present *scutellaris* group will be found to be practically equivalent to *Doliosyrphus* of Williston, a division hardly warranting generic separation. In the present paper an effort has been made to shorten descriptions as much as possible, and all possible details have been included in the group descriptions. Moreover, a number of general structures of unessential value are not described, in order that those features of importance may be more carefully described. Hence such parts as the pleuræ, first abdominal segment, hypopygium, venter, etc., are seldom mentioned, and only when containing characters of importance. The present study would indicate that certain characters formerly used are of but little value, and likewise the reverse. The genus, or more exactly the groups, contain for the most part a number of very close species; few, in most of the groups, are separated by more than two or three characters. Group characters in general consist of size, form or shape of head and abdomen, pilosity of eyes, extent and length of pile, thickening of hind femora, nature of coloration and markings, etc. Specific characters embody a much larger assemblage, but are most largely drawn from the pile of the various body regions, and the markings of the abdomen, thorax and legs. Whereas in some species the degree of opaque markings of the abdomen makes good distinctions, in other species it seems entirely too variable. The same may be said of the abdominal pile. The scutellum rarely contains specific characters, but seems to in part characterize the groups. All the species of the *albifrons* group, known to me, have this structure opaque clear yellow.

Some seventy-one species are listed at the present time from North America. Twenty-three of these remain known only by the original descriptions. Of the forty-eight remaining forms, material has been obtained of forty-two, and the characters of the remaining six are well enough known to allow of their position being readily ascertained. An attempt has been made to place within their respective groups the remaining twenty-three species, and to indicate their apparent relationships. It is hardly possible to perfect completely a scheme of division within such a large group; the present study is offered however, in the hope of serving and facilitating the classification of a very interesting and, at the same time, as a whole, comparatively little known group of flies.

Key to the groups within the genus *Eristalis*.

1. Species with the thorax and abdomen thickly long pilose; feebly shining. *pilosus* group
   Species nearly bare or short pilose, wholly opaque or strongly shining.....2
2. Thorax marked by very distinct fascia of black and lighter color; usually opaque. Generally to a large extent yellowish or reddish in color.....3
   Thorax unicolorous, or at least with but very obscure fascia; usually shining. Forms seldom largely yellowish.....5
3. Thorax longitudinally fasciate (eyes spotted, cf. *aeneus*).....*furcatus* group
   Thorax transversely fasciate.....4
4. Hind femora considerably thickened; abdomen more elongate, *scutellaris* group
   Hind femora quite slender, or of not more than normal thickness; short, normally shaped species.....*albifrons* group
5. Thorax dull, feebly shining.....7
   Thorax polished, shining.....6
6. Metallic species, eyes spotted.....*aeneus* group
   Not metallic species, eyes not spotted.....*dimidiatus* group
7. Hind tibiae arcuated and considerably flattened or compressed; larger species.....*obsoletus* group
   Hind tibiae normal, usually smaller species.....*arbustorum* group

The Pilosus Group.

Group description.

The members of the *pilosus* group are separated from several other groups, *dimidiatus*, *arbustorum*, *obsoletus* groups, by only two or three characters, but these seem fairly good ones. They present a quite characteristic appearance in being heavily long pilose species, usually but feebly shining. With respect to the former character, *occidentalis* may offhand, from some specimens, appear rather short pilose. A closer examination of species of the *dimidiatus* or *arbustorum* groups, will show that the species are not to be confused. Especially is the thickness

of the pile apparent about the face. The species *tenax* (*obsoletus* group) might possibly be confused in the pilosity of the head and thorax, but the abdomen of that species should be sufficient to separate the species with certainty, the abdominal pile of *tenax* being comparatively short. The abdomen, in the group, is usually much more shining than the thorax, and the former may be even somewhat metallic, as on the third and fourth segments of many specimens of *bastardi*, etc. The members of the *dimidiatus* group should not be confused with the present in this respect, as the thorax of the former are very definitely "shining," with the possible exception of *E. nemorum;* that species is markedly short pilose.

But little may be said of the *pilosus* group in a general descriptive way. Its members vary from medium size to quite large (for the genus). Several characters are highly variable; these being chiefly the infuscation of the wings, opaque areas of the abdomen, etc.

Antennæ dark in color, of the usual shape; the arista varies from bare to pubescent, to very short pilose basally, in such species as *occidentalis*, *bastardi*, *anthophorinus*, etc.; moreover, these three species are otherwise closely related. In *circe*, the antennæ are described as quite long plumose basally, for an *Eristalis*. Facial stripe prominent.

Thorax dull black, but little shining; heavily obscured with pile, the pile usually light in color. There seems to be a marked tendency towards the possession of obscure darker spots or vittæ upon the thoracic dorsum and moreover, this will in general be found true of the more opaque members of the whole genus. The species *nemorum*, together with the least shining members of the *arbustorum* and *obsoletus* groups, all show such vague and ill defined markings, which, however, should never be confused with the more definitely fasciate and vittate species as found in the *albifrons* and *furcatus* groups, etc.

The abdomen is somewhat more shining than the thorax; usually with light colored spots laterally, on the second and sometimes the third segments. The typical narrow, yellow cross bands, found so commonly on the posterior margins of the segments, in the *dimidiatus* group, are here almost entirely lacking, thus affording an additional difference between the groups. They are here present only in *occidentalis*.

Legs almost wholly dark in color; tarsi sometimes light. In most species the hind tibiæ are basally, sharply yellowish to

reddish, as is true of a large proportion of the genus; however it is not so constant here as in other groups, the species *occidentalis* and *pilosus* being often found wholly dark. Hind femora quite slender, to considerably, though not heavily, thickened, as in *flavipes*. Hind tibiæ normal, except in *flavipes*, where they are occasionally considerably arcuated and flattened.

Eyes wholly and heavily pilose, with the exception of a narrow strip on the lower occipital margin of the eye, more extensive and likewise less dense in the females. The members of the *dimidiatus* group have the pile usually confined to practically the anterior half of the eye, but the character can not be used to set the groups apart.

Wings never wholly hyaline (except sometimes in males of *flavipes*); usually with only a sharply defined, irregular brown band or line, running transversely across the middle of the wing, but often with this whole area heavily infuscated; in *flavipes* the whole basal two-thirds of the wing and especially the veins, may be brown.

Several European species are members of the group, as *intricarius*, *anthophorinus*, etc. The latter has been found to be the same as the species *montanus*, described by Williston.

Key to the species of the *pilosus* group.

1. Scutellum black ..... *persa* Will.
   Scutellum not black 2
2. Hind tarsi reddish 3
   Hind tarsi dark brown or black 4
3. Scutellum whitish, whitish pilose; anterior half of thoracic dorsum black pilose ..... *oestracea* Linn.
   Scutellum yellowish, yellow pilose; anterior half of thoracic dorsum yellow pilose ..... *flavipes* Walk.
4. Thorax yellowish red in color ..... *circe* Will.
   Thorax brown or black 5
5. Abdomen broadly yellowish to reddish on the sides, leaving a median black stripe, that is opaque on the anterior half 6
   Abdomen not broadly yellow along the sides 7
6. Posterior margins of abdominal segments never with narrow yellow bands, *anthophorinus* Fallen
   Posterior margins of segments always with narrow yellow bands, *occidentalis* Will.
7. Third segment with an opaque crossband posteriorly 8
   Third segment with two opaque circular spots near the middle .. *pilosus* Lw.
8. Abdominal pile, largely, or in part black; abdomen never with yellow posterior marginal bands on the segments 9
   Abdominal pile wholly yellow; yellow marginal bands present on the segments ..... *occidentalis* Will.
9. Larger species. Yellow spots of abdomen paler, thorax unicolorous in appearance, posterior opaque band of third segment quite narrow or wanting ..... *mellisoids* n. sp.
   Smaller. Spots of abdominal segment often reddish; thorax with the appearance of being much blacker on the disc. Posterior opaque band of third segment usually decidedly wider ..... *bastardi* Macq.

Eristalis occidentalis Williston.

Male and *Female*. Antennæ black; arista very short pubescent. Ground color of face, cheeks and prominent facial stripe, shining black. Color of face obscured beneath dense yellow pollen; likewise clothed with long, thick, yellow hair; pile of front and vertex, abundant, yellow. Thorax dark brownish black, feebly shining, the females not differing from the males in this respect, as they do in the *dimidiatus* group. Clothed with abundant yellow pile. The obscure vittæ of the thorax, found in several members of the group, are more than usually prominent in *occidentalis*. There are two such vittæ, lighter in color than the rest of the thoracic dorsum, with sometimes a third in between. They are never strongly marked anteriorly and are occasionally with difficulty made out. The ease or difficulty, with which obscure vittæ may be seen in any group, depends largely on such factors as dust, dirt, grease, etc. Scutellum brownish yellow, moderately shining, pile yellow. Abdomen brownish to slightly greenish black; in a rather large degree, quite shining. The males differ from the females in being much more shining, and highly brassy or æneous, on the third and fourth segments. Both males and females seem characteristic in having narrow yellowish to reddish, posterior marginal bands on the second, third and fourth segments. The spots of the female, are confined to the second segment. In the male, they extend more or less broadly on to the third segment likewise; in both sexes they are quite often tinged with brownish or reddish, but never markedly reddish. Pile of abdomen in both sexes wholly yellow. Legs of the group type; hind femora slender; pale basal area of tibiæ rarely wanting, usually prominent. Wings always infuscated to some extent in the middle of the anterior half, the infuscation usually slighter in extent, and more sharply delimited from the basal area of the wing, than is found in its near ally, *bastardi*.

Length of the species, 10 to 12 mm. Material studied is from Washington and British Columbia.

This species is one of several, comprising the *occidentalis* complex, the species of which are certainly troublesome to separate, owing to considerable intra-specific variation and to the complexity added here, as in other groups, by various European species. The species *occidentalis*, *bastardi*, *mellissoides* and *anthophorinus* form a group that are closely allied and a discussion of the situation, that may serve to show their relationships, is included under this species. The characters of face and legs, in these four species, are so similar that there is naught to be found to separate them, leaving only the pile and the markings of the thorax and abdomen to distinguish them. However, the study of a good series shows these characters to be comparatively trustworthy.

Occidentalis has been separated from *bastardi* formerly, by the wider, opaque, posterior band of the third segment of the latter, together with the presence of a median opaque spot, sometimes present, on the fourth segment of the former. The question of the median spot of these segments has been taken up in more detail in the *dimidiatus* group. While most *occidentalis* show the spot rather prominently, and most *bastardi* have the segment wholly shining, many of the latter show traces of such a spot. For this reason little emphasis has here been laid on the presence or absence of the spot. The species *bastardi* is considered in this paper to be definitely characterized by the presence of extensive black pile on the abdomen, both anteriorly as well as posteriorly, the fourth segment, it is true, being usually yellow pilose, as well as the yellow spot of the second segment. Further, the fourth segment is usually wholly shining, the posterior, opaque margin of the third segment, usually rather wide; the spots of the second segment more obscure. In five males only, out of a considerable series, do I find very small yellowish spots on the anterior corners of the third segment; they are always much more prominent in the males of *occidentalis*. A number of specimens have come to me for study, in series of *bastardi*, that have the abdomen wholly yellow pilose; these forms seem to differ in still other ways, and I consider them to be wholly different from either of the two species just mentioned. I have placed them in the European species *anthophorinus*, discussed below. Thus characterized by its extensive black pile, *bastardi* may only be confused with *mellissoides*. The median spot of the fourth abdominal segment, the narrow or wanting, posterior opaque bands of the latter, on the third segment, together with the but slightly vittate thorax, should separate them. The specimens of *mellissoides* are certainly larger than any *bastardi* I have ever seen. Lastly, the infuscation of the wings in the latter is usually greater in extent, and more diffused than in that species.

Among a series of specimens of *occidentalis*, I find several males and females that do not agree. They are undeniably close to that species, but the differences are such that I believe one is warranted in considering them as a distinct species, and I have so considered them here. I have called it *mellissoides*, and although described in more detail further along, it is likewise compared with *occidentalis*. The female of the latter

contrasted with the other, shows the spots of the second segment to be more shining, more reddish, and the pile of the abdomen wholly yellow. The pile of *occidentalis*, further, seems to be slightly shorter and has the appearance, off hand, of being depressed somewhat. The narrow yellow posterior bands of the segments, in that species, are lacking in *mellissoides*. The thoracic vittae are much less prominent, and the four specimens of the latter are considerably larger. The species has the pile of the second abdominal segment posteriorly, the third segment, and in one specimen, the fourth segment, wholly black; the pile seems a trifle longer, more erect and abundant; the spots of the second segment, while distinct, are less shining.

The males of the species differ perhaps more markedly yet. *Occidentalis* has the yellow spots of the second and third segments, broadly confluent; the spots of *mellissoides* are separated narrowly, by black posterior bands and the spots themselves are less prominent. The pile of the former is wholly yellow; of the latter yellow, with transverse black bands on the second and third segments, and there are no yellow margins on the segments posteriorly.

Eristalis mellissoides n. sp.

Female. Facial stripe and cheeks black. Antennæ black; arista short plumose basally, its hairs perhaps a trifle shorter than in *occidentalis*. Ground color of face, light, loose, yellow. Pile of front, save just before the ocelli, vertex and occiput, long, light yellow. Thorax dark greenish brown or black, obscured by dense, long, yellow pile; vittæ usually very much obscured; faintly shining. Scutellum, yellow, more shining; subtranslucent; pile yellow. Whole of pleural pile yellow. Abdomen black; second segment with a light yellow spot on either side, separated by black, the width of the black median band, one-third or more of the width of the segment. Spots of second segment shining, and the black likewise, narrowly, immediately behind the spots. Third segment shining, an uninterrupted, opaque black band, often quite narrow, on both anterior and posterior margins, the anterior band frequently with a median prolongation posteriorly. Fourth segment wholly shining, save for a median triangular spot on the anterior margin, directed posteriorly. Pile of abdomen abundant; on first segment wholly yellow, sometimes the posterior half black; third segment wholly black; fourth and following segments usually yellow, sometimes narrowly black, anteriorly. Legs black, black pilose; the basal half of hind tibiæ, basal third of front and middle tibiæ, pale yellowish to brownish white, white pilose; short, stiff pile of tarsi brownish. Wings infuscated in the middle and anteriorly, the marking

more sharply delimited, and less extensive than in *occidentalis*, *bastardi*, etc.

Male. Similar to the female. Yellow spots on both second and third abdominal segments, the latter the smaller; the black abdominal pile is in the form of transverse bands on the posterior margin of the second and third segments. Fourth segment as in *occidentalis*, shining metallic, a minute, median triangle, anteriorly.

This form is, as shown above, close to *occidentalis*. However, it seems certainly distinct, in the large size, largely black pilose abdomen, and total lack of yellow margins on the segments, albeit, these are often obscure in the latter species. Length, 10 to 14 mm.

Five males and six females. Type male, allotype female, and six paratypes, from Dr. R. C. Osburn's collection, from the following localities: Victoria, B. C., July 4, 09; April 10, 09; Vancouver, B. C., April 27, 07; Port Renfrew, B. C., August 16, 01; Gabriola Is., B. C., May 8, 08. Three paratypes in Professor A. L. Lovett's collection, Corvallis, Oregon, June 3, 99.

Eristalis bastardi Macq.

A detailed description has not been thought necessary, as a careful comparison with the species has been given. Williston recorded it from New England, Canada and Labrador. I have studied specimens from New Jersey and Ohio. Apparently an eastern species.

Eristalis anthophorinus Fallen.

E. montanus Will. Proc. Amer. Phil. Soc. xx, 322.

A number of specimens from both eastern and western United States, (North Dakota, Alaska, New York, New Jersey), have been separated by the writer, from collections loaned for study, mostly passing under the name *bastardi* or *occidentalis*. They surely belong to the European species, *anthophorinus*, and I have compared them with European material. From *bastardi* they should at once be separated by the wholly yellow pilose abdomen. Only one character remains to distinguish the species from *occidentalis*, this being the presence of yellow marginal bands on the segments of the latter, posteriorly. *Occidentalis* was described from only six specimens, but this is one of the characters included in the original description. These bands seem altogether too prominent in most specimens of that

species, and too plainly lacking in the other, to consider them as otherwise than distinct. Moreover, *anthophorinus* has the thorax never so prominently vittate, as in the other species. Superficially, it the more resembles that species, in that the third and fourth segments of the males, in both, are aeneus.

Close as the species approaches *occidentalis*, it is even nearer to *montanus* Will. The latter was described from a single specimen. Some sixty or seventy specimens, of what is evidently Williston's *montanus*, have been collected and so determined, by Prof. J. S. Hine, in Alaska. This series enables us to understand that species much more completely. There is no doubt in the mind of the writer but that the two species are synonyms. About thirty specimens of the above mentioned series may be distinguished by having the black median stripe of the abdomen, decidedly black pilose; *anthophorinus*, on the other hand, is described by European authorities as wholly yellow pilose on the abdomen, and in this, my specimens from the United States agree. However, some of the Alaskan specimens are likewise wholly yellow pilose; about half a dozen specimens show traces of black pile on the mid-dorsum of the abdomen. All my European specimens, as well as the ones from the United States, show the spots of the abdomen reddish yellow. In the whole Alaskan series they are decidedly red, with little or no yellow. All of these specimens are rather large in size as compared with the others and the black is a trifle more extensive, perhaps. The type of *montanus*, itself, is described as wholly yellow pilose on the abdomen. Whether the black pilose forms, from Alaska, is separable or not, must await the study of more European material. At any event, it could not be *montanus*. The type of this species was from Wyoming.

This species is described by Lundbeck as always with yellow to a greater or less extent on the sides of the abdomen, on the third segment and usually the fourth, likewise.

Male and *Female*. Antennæ brownish black; arista very short plumose to microscopically pubescent basally. Facial stripe and cheeks shining black. Face light in color; pile abundant, but loose, of medium length, yellow. Pile of eyes thick; black. Thorax dark greenish or brownish black, obscured by thick yellow pile; vittæ nearly wanting, very indistinct. Scutellum yellow to brownish, subtranslucent; pile yellow. Abdomen reddish yellow; a broad black median stripe, slightly extended towards the sides posteriorly, on the margins of segments two, three and four, sometimes almost reaching the lateral margin, and

likewise slightly extended to the sides anteriorly, widely dilated on the second segment. First segment wholly black. Pile of abdomen of medium length, wholly yellow, slightly blackish in the middle of one specimen from New York. Legs black; apices of femora very narrowly, basal third or fourth of front and middle tibiæ, and basal half of hind tibiæ, yellowish. Length, 10–12 mm.

Four specimens are rather peculiar in appearance, due to the absence of light spots on the third and fourth segments, except very slightly in two of them, in the anterior corners of the third. As mentioned above, they may be called var. *perplexus*, n. var.

Holotype male and three paratypes, males, in the coll. of Dr. R. C. Osburn.

Description taken from both European and American specimens. I have a dozen or more of the latter, at hand, from the following localities: Vernon, B. C., Sept., 02; Port Renfrew, B. C., Aug. 16, 01; Regina, June 18, 07; Banff, Alta., Paterson, N. J.; White Plains, N. Y.; Aqueduct, N. Y.; Caledonia, N. D. (Dr. R. C. Osburn's collection).

The species has been discussed above. The males are very much like the males of *occidentalis*, but the females of the two species markedly differ from one another.

Eristalis pilosus Loew.

Male and *Female*. Antennæ black, arista bare to microscopically pubescent. Facial stripe and cheeks shining black. Ground color of face black. Pile of face, front and vertex, loose, sparse, and pale yellowish white. Thorax dark greenish black, but slightly shining. Scutellum yellowish brown, subtranslucent. Pile of thorax and scutellum, pale yellowish white, with something of a greenish tinge. Abdomen black, light greenish to brownish yellow spots on either side of the second segment, shining, separated from the posterior margins by a band of black. Abdomen shining, on the second segment anteriorly, on the third segment, two characteristic, oval spots in the middle, opaque. Pile of second segment except a narrow posterior band, and fourth segment, wholly yellow; otherwise black. The black and yellow pile is rather sharply delimited, giving the abdomen a decided banded appearance. Legs black, base of tibiæ sometimes very narrowly light brownish to yellowish, usually black. Hind femora quite slender. Wings usually wholly hyaline, occasionally with a slight infuscation in the middle. Length, 11–13 mm.

At once the least known and best distinguished species of the group. Some twenty specimens were collected and so identified, by Professor J. S. Hine, from Savonoski, Alaska,

July, 1919. A specimen from Hopedale, Labrador, has been loaned by Mr. C. H. Curran. Easily separated from the other species of the group by the slender femora, characteristic band-like pile of the abdomen, circular opaque spots of the third segments, etc. The wings are more hyaline, the arista bare, the color of the pile somewhat peculiar, etc.

Eristalis flavipes Walker.

Antennæ dark brown; arista decidedly plumose on the basal half. Face, cheeks and facial stripe, shining black. Pile of face, front and vertex, sparse, long, yellow. Thorax black, feebly shining, obscured by very dense, long, yellow pile, less abundant in the middle or disc of the thorax, and thus allowing the ground color to show as a centralized black spot; pile of disc of thorax often interspersed with black. Abdomen black, largely shining. Pile of second segment basally, and of fourth segment, slightly yellow; remaining segments black pilose. Legs black, black pilose; hind tarsi characteristically reddish orange, pile similarly colored. Front and middle tarsi sometimes likewise reddish. Wings always more or less heavily infuscated in the females; always practically hyaline in the males. Some thirty typical specimens, from both Atlantic and Pacific states. Length, 13–17 mm.

Various specimens depart from the above description, to form well marked varieties, and in fact, the species is one of the most variable of Syrphids; within the genus, only *E. intracarius* of Europe, rivals it in degree of variation.

The first of these may be characterized by the more extensive black pile in the female, on the disc of the thorax. The abdomen is wholly yellow pilose. This seems to be Loew's variety *melanostomus*. Three females only. Massachusetts, New Jersey and New York.

A second form differs from the typical specimens in having the abdomen broadly reddish pilose on the second and third segments. The black of the thoracic disc is in the form of a sharply marked transverse band, usually reaching to the base of the wings. Nine specimens, both males and females, Alaska, Idaho, Oregon and Wisconsin. There seems to be a marked tendency to assume a reddish coloration in pile of more northerly distributed forms. *Volucella bombylans*, likewise, exhibits such a color phase. The form may be known as variety *rufipilis*, n. var.

Holotype male and allotype female in the collection of writer; paratypes in O. S. U. collection and of Dr. R. C. Osburn.

A notable character of *flavipes* is the marked difference in size and appearance of males and females. The males are considerably the smaller, though an occasional specimen will reach the size of a small female. The yellow pile of the typical male is sharply marked and band-like. This species is not to be confused with any other, the red hind femora, wholly black abdomen, large size, etc., distinguishing it.

Eristalis oestraceus Linne.

Male and *Female.* Antennæ dark brown; arista short plumose basally. Face, facial stripe and cheeks shining black. Pile of face, front and vertex, almost white, rarely yellowish on the front. Pile of eyes black. Thorax black, feebly shining; pile of anterior two-thirds and pleuræ, abundant, deep black; pile of remainder of thorax and scutellum, white. Scutellum peculairly whitish, faintly shining. Abdomen black; opaque, save for the anterior corners of second segment, a transverse band in the middle of the third, nearly the whole of the fourth, shining. Pile of abdomen basally, similarly to scutellar pile; on the second segment posteriorly, and the whole of the third, black. The pile of the fourth segment, forms a sharply marked transverse band, reddish yellow or orange in color. Legs black, black pilose; hind tarsi, and front and middle tarsi less sharply, reddish yellow, reddish pilose. Length, 11–15 mm. (From European Material).

A striking, easily distinguished species. First recorded by Walker, from the Hudson Bay country, as *Eristalis* (*Syrphus*) *oestriformis* Walk. Austen has, as pointed out by Dr. R. C. Osburn, (J. N. Y. S. S. vol. XXIII, p. 144), shown *oestriformis* to be a synonym of *oestracea L.* There is no reason why the species should not occur in this country. Walker's type is in the British Museum.

Eristalis persa Williston.

This species quite evidently belongs in this group. No specimens have been studied, but Williston's description does not leave its relationships in doubt. The salient features of the species are given below. Face shining black, long yellowish white pilose. Antennæ reddish yellow. Thorax and scutellum black, the latter shining, the former more opaque. Pile of thorax entirely light yellow, posteriorly and on the scutellum, black. Abdomen black, black pilose; largely shining. Legs black, tips of femora, hind tibiæ, whole of four anterior tibiæ, and all the tarsi, light yellow; hind femora slender.

Female. Length, 12–13 mm. Guerrero, Mexico.

Eristalis circe Williston.

No specimens of this species have been seen. The description and figure by Williston leave no doubt as to its position. The thorax is dark ochraceous, the scutellum and abdomen, with the exception of a black spot medianly on the anterior margins at second and third segments, light yellowish red. Pile of thorax and abdomen, similarly colored. Face shining black, yellowish on the sides; pile yellow. Third antennal joint reddish; arista quite plumose. Legs, black; four anterior tibiæ, for the larger basal part, the base of the hind femora, and the base of the four anterior tarsi, more or less, yellow. Male. The female differs from the male in having the abdomen black, black pilose, except in the middle of the second segment, where it is similar to the pile in the male. The hind femora of the male are described as moderately thickened; of the female as not thickened.

Length, 12–13 mm. Guerrero, Jalapa, Oaxaca, Mexico.

The Furcatus Group.

Group description

Species of small size; very short pilose. Face of the usual type in profile; prominence rather less than average. Third joint of antennæ very little longer than broad; arista bare. Eyes heavily pilose, almost confined to the anterior half, heaviest above. Facial stripe well developed; face heavily covered with pruinescence; normal in shape. Thorax opaque, strongly marked with longitudinal bands or fascia; sometimes broken up into spots; usually interrupted at the suture. Scutellum variable. Abdomen usually considerably marked by yellow; largely opaque; of the normal shape. Hind femora varying from considerably thickened to slender; hind tibiæ slender, sometimes considerably arcuated, never flattened. Wings hyaline.

Key to species of the *furcatus* group.

1. Stripes of the thorax very much obscured and feebly indicated.....2
   Stripes quite distinct and prominent.....4
2. Cheeks black.....*phillipii* Schiner
   Cheeks reddish.....3
3. Third and fourth abdominal segments reddish; brown anterior border of second segment obsolescent.....*ornatus* Town.
   Third and fourth segments blackish; brown anterior border of second segment not obsolescent.....*ochraceous* Will.

4. Stripes of mesonotum limited to posterior half; broken up into spots, *trigonus* Will.
   Stripes run nearly the full length of the thorax.....5
5. Scutellum yellow, opaque.....*Texanus* n. sp.
   Scutellum black or brown.....6
6. Scutellum wholly shining, dark brown or black, sometimes metallic, *furcatus* Wd.
   Scutellum pale brown medianly, shining, never metallic; velvety black on either side.....*quadraticornis* Macq.

Eristalis phillipi Schiner.

(Plate II, Figs. 13, 16).

Male. Antennæ reddish brown. Face densely covered with pale yellowish pollen; pile of the same color. Facial stripe, shining light yellowish brown. Cheeks black. Markings of thorax quite variable. Before the suture are four dark brown stripes, the inner two sometimes blackish. The two "inner," dark colored stripes, continuous behind the suture, recurved posteriorly on the outer side into a large oval, black spot, the latter sometimes pale centrally, thus appearing horseshoe shaped. Before the suture, the spaces between the above mentioned stripes, are narrower, of a lighter brown color and more or less continuous past the suture. Narrow, whitish, sutural line, conspicuous. Pile of thorax slightly brownish yellow. Scutellum wholly opaque, clear yellow; pile rather long. Second segment of abdomen clear yellow, with a wide black median stripe, deeply concave on either side. Third segment of the same color, with a similar median band, of nearly the same width, somewhat dilated posteriorly; the yellow sometimes obscurely dark brown. Fourth segment opaque black, with a transverse metallic band, narrowly interrupted medianly. Femora, except the narrow apices, black. Hind femora slender. Hind tibiæ dark reddish brown, sometimes black in the middle. Front and middle tibiæ pale yellowish; sometimes dark brown on the third. Wings wholly hyaline.

Female. Differs from the male as follows: Stripes of thorax before the suture, rather indistinct; "inner" black stripes replaced by a pair of nearly round black spots. Large "outer" spots, behind the suture, broken on the posterior side, resembling an interrogation mark, the posterior ends connected by a median transverse band. Median stripe of a second segment wider, dilated posteriorly, continuous with a narrow posterior marginal band. Third segment wholly black, or with a very small yellow spot in the center on each side. Length, 9–12 mm.

Six specimens. Colima, Valparaiso, Quillota, Chile; Buenos Aires, Argentina.

Eristalis ornatus Town.

No specimens of the species have been seen. The color of the cheeks is not mentioned, but the species is described as resembling *ochraceus* Will. The chief features as described are: Pile of frontal triangle yellow, intermixed with black. Second,

third and fourth abdominal segments reddish yellow; linear brown stripe of second and third segment obsolescent. Legs deep reddish yellow; proximal half of middle and front tibiæ yellowish white. Hind femora narrowly and faintly brownish distally, above. Tarsi wholly reddish yellow. Wings hyaline, a small, well defined, quadrate, blackish spot at end of auxilliary vein, between the latter and the first vein. Two males. San Rafael, Lower Calif., July. C. H. T. Townsend. The thorax is not described, except as "resembling *ochraceus*." Length, 10–11 mm.

Eristalis ochraceus Will.

One poorly preserved male, from Bartica, British Guiana, may belong here, although there are several discrepancies. The thorax shows four blackish stripes, but the ground color is gray, not ochraceus yellow. Scutellum brownish basally, clear yellow on the outer half; wholly opaque. The third abdominal segment is the same color as the second, with a small round median spot, not black, with reddish lateral spots; it shows in addition, a marked flattening, obliquely, from a side view, of the front, that is not mentioned by Williston; moreover, the ocelli are raised on a small, but conspicuous prominence. Facets of the eyes distinctly enlarged. Quite possibly it is distinct. Length, 10 mm.

The characters as given by Williston are briefly as follows: Face yellow; thickly light yellow pollinose; cheeks shining red. Eyes slightly pilose; facets on upper half distinctly enlarged. Mesonotum, densely opaque, ochraceus yellow, with similarly colored pile; four to six slender stripes, feebly indicated. Scutellum opaque reddish yellow. Second segment of the abdomen, the color of the scutellum, with a slender blackish brown anterior margin, a linear brown stripe, and a narrow, posterior, blackish brown band in front of the yellow hind margin. Third segment blackish, with a red lateral spot and hind margin, and a narrow, entire, shining median band. Legs red, base of tibiæ and tarsi, except tips, yellow; distal part of hind femora and a ring on hind tibiæ, blackish, etc. Wings hyaline. Length, 12 mm.

Chapada, Brazil. One male. Williston.

Eristalis trigonus Will.

Not seen; the description, however, leaves no doubt as to its position. The characters are briefly given below.

Male. Face amber colored, densely yellowish pollinose, yellow pilose; facial stripe shining. Cheeks black. Antennæ yellowish red. Eyes densely pilose. Thorax before the suture, opaque brownish gray; behind the suture with three large, opaque, velvety black spots, the median one elongate oval, the lateral ones forming a right angled triangle, with the hypothenuse slightly concave. Pile yellowish brown. Scutellum opaque reddish brown, more blackish at the base. Second segment of abdomen yellow, with a wide median black stripe, either side concave, and somewhat narrowly dilated along the posterior margin. Third segment with a median, opaque black stripe and a narrow, brown or blackish posterior band. Fourth segment reddish or brown, with a narrow, shining black crossband. Legs: femora, except the tip, tip of four anterior tarsi and hind tarsi black, elsewhere red; hind femora thickened. Wings hyaline.

Female. Front with an opaque black band below ocelli; pile black. Abdomen shining black; second, third and fourth segments each with a narrow yellow hind margin and a posterior, opaque black band; second segment with an anterior band, connected broadly in the middle with the posterior one; third segment with an anterior oval spot, opaque black. Length, 9–11 mm. Guerrero, Mexico.

A striking species.

Eristalis texanus sp. n.

(Plate II, Fig. 21).

Female. First two joints of antennæ black, third joint dark brown. Facial stripe and cheeks shining black. Face covered with very dense whitish pollen, extending halfway up the front, becoming darker at the vertex, and pile of the same color. Ground color of the thorax, opaque ashy gray, marked with black as follows: Four stripes, the outer pair, slightly wider, and interrupted by a short space at the suture, thus forming two spots on either side, the posterior one of which is more or less triangular; inner stripe continuous past the suture, uninterrupted. Pile pale yellow. Scutellum clear yellow, wholly opaque. Second segment of abdomen opaque black, with a not very large, slightly brownish, deep yellow spot on each side, somewhat roughly triangular, the pointed ends directed inward; widely separated by black medianly; posterior marginal border of segment, black. Segments three, four and five, each shining metallic black or brassy, narrowly interrupted medianly, with a narrow, opaque black marginal band. Femora shining black, narrowly yellow at the apices. Basal third of front and middle tibiæ, becoming reddish medianly and black on the apical portion. Larger, basal portion of first joint of middle tarsi, yellowish; remaining

tarsi black. Hind femora considerably thickened; hind tibiæ slightly flattened. Wings hyaline. Length, 9.5 mm.

Type female: Coyote Lake, Bailey, Co., Texas, August 24, 1921. Collection of F. R. Cole.

Eristalis furcatus Wied.

(Plate II, Figs. 11, 20).

Male. Antennæ light reddish brown. Facial stripe and cheeks shining black. Face covered with pale yellow pruinescence, and pile of the same color. Pile of front and vertex blackish; of eyes yellowish. Facial knob rather prominent. Thorax opaque gray before the suture, becoming slightly shining, with a steel blue cast, behind; marked with black as follows: Four opaque black stripes, the inner two narrowly separated, continuous and confluent a short distance behind the suture, thence extending as one, resembling a two-pronged fork. Outer pair slightly wider, tapering from either end somewhat, and interrupted at the suture. Scutellum dark brownish, highly shining metallic, more lutescent on the rim. Second segment of abdomen black, feebly shining, a not especially large, subround spot on either side, brownish yellow, variable in size. Third segment black, with similar, but slightly smaller and a narrow, metallic cross band, slightly interrupted medianly; an opaque black margin posteriorly. Fourth segment opaque black, a metallic cross band, narrowly interrupted medianly. Hind femora considerably thickened, black, brown apically. Front and middle femora, dark brownish black. Front and middle tibiæ and tarsi, and hind tarsi, dark brown; hind tibiæ reddish brown. Wings hyaline.

Female. Similar; upper half of vertex blackish; bare calloused spot above antennæ, light shining brown, surmounted by a rounded, shining black spot. Abdomen wholly shining, slightly metallic black; light spots obsolete; yellow posterior marginal bands obsolescent. Length, 10 mm.

About twenty-five specimens, from Corumba, Sao Paulo, Rio de Janeiro Brazil; Guerrero, Mexico; Amatitlan, Guatemala. Also is recorded from Colombia, Montevideo and the Argentine Republic.

Eristalis quadraticornis Macq.

(Plate II, Figs. 12, 18, 22).

Male. Antennæ black; third joint short, sub-quadrate, with a slight obliquely truncate appearance; arista shorter than usual and somewhat thickened basally. Facial stripe and cheeks shining black. Face somewhat deeply and acutely produced. Eyes densely and rather long pilose for an *Eristalis*. Face pale yellowish pruinose; pile of the same color. Pile of front black; of vertex, pale whitish yellow. Thorax, opaque dark grayish brown, with complicated markings of opaque black and pale grayish brown as follows: The pale markings in the

form of a narrow median line, slightly widening posteriorly and continuous with on either side, a roughly R-shaped figure, the latter turned outward, and extending nearly the whole length of the thorax. The upper (anterior) closed circle of the R, is dark brown in the middle, and sometimes lined with a dark band or ring; the posterior, open circle, is lined with an opaque black band. Scutellum shining, grayish brown in the middle, opaque black on either side. Abdomen opaque velvet black, with lighter markings as follows: Second segment with a pale brownish yellow or orange spot on either side, extending more narrowly, the full length of the third segment also, on the second segment sending a small, rounded lobe medianly; hence leaving a wide, deeply concave, black median band; yellow spots extending along the side margins. Median black band of third segment, wider, lateral margins also black. The fourth segment wholly black, a shining cross band, narrowly interrupted. All the femora shining black, narrowly yellowish apically; hind femora somewhat thickened. Tibiæ dark brown, yellowish basally. Tarsi dark brown. Wings hyaline.

Female. Similar; front, with a small round, opaque black spot, on either side, just in front of the ocelli, touching the eyes. Light spots of abdomen usually obsolete, when present, confined to the second segment; similar to the male, darker.

Length, 8–9 mm. Six specimens. Santiago, Chile.

The Albifrons Group.

Group description.

The species of this group all exhibit an unusual amount of yellowish, sometimes reddish color, marked by black. All of medium size with the exception of *minutalis*. Third joint of antennæ rounded, a trifle longer than broad; arista, except in *transversus*, bare to microscopically pubescent, thickened basally. Face light to dark in color, but in every case obscured by dense, appressed, light colored pile. Occiput covered with similar pile; that of front and vertex longer and more erect, sometimes dark in color. Cheeks and a median facial stripe from just below the antennæ to epistoma, bare, shining. Dorsum of thorax velvet black in color, marked by from one to two ashy or cinereus bands, a band being just before the suture, the pre-sutural band, and the other behind the suture and just in front of the scutellum, the post-sutural or prescutellar band. In addition the area just between and below the humeri is sometimes ashy in color, forming a third band, but is not considered here. Pleuræ likewise ashy gray, covered with fairly long, sparse pile. Scutellum opaque yellow, sub-translucent. Pile

of thoracic dorsum abundant but quite short, light in color though generally dark on the black areas. First abdominal segment yellow or black. The second yellow to red, marked by a median black line or triangle, its base on the posterior border and sometimes extending to the lateral margins, its apex usually reaching the anterior margin. Third segment with a spot in the anterior corners, yellowish, interrupted medianly by a black band that usually extends to the sides posteriorly, but is often attenuated or broken in the middle, leaving the anterior half a small round black spot. Fourth segment with similar though smaller yellow spots in the anterior corners, very often wholly black.

Hypopygium shining black. Pile of abdomen short, sparse, light in color, dark on the black areas, longer posteriorly. Segments two, three, and four with the characteristic, narrow, yellow posterior marginal bands found in so many species of *Eristalis*. The abdomen is typically opaque with a small, shining to metallic, often interrupted band on the fourth segment, and occasionally a similar though smaller area on the third segment.

Legs: Femora and a part of tibiæ generally shining black; knees and tarsi usually light in color. Hind femora slender, only very slightly thickened in one or two species. Wings hyaline, rarely with an infuscated area near the stigma.

The principal characters that have been used in this group, as will be seen from a study of the accompanying keys and descriptions, are the arrangement of the thoracic bands together with the configuration and extent of the black markings of the abdomen, particularly of the second segment. The group may readily be divided up on the basis of one or two ashy bands on the thorax, or of the number of black bands. Two species seem to have the ashy color of the thorax a pure gray in contrast to the brownish tinged bands of the remaining species. On the abdomen several species seem quite characteristic in having the median black band, rather wide, and unattenuated posteriorly; in the others it is usually triangular. Three species have the hind femora to a slight degree more thickened than the remaining members.

A considerable series of specimens seems to demonstrate the decided value of the characters mentioned above. Some slight

variations occur, but these do not seem greater than are to be expected. They consist largely in the amount of yellow or black coloration or pigment of the abdomen, color of the legs, etc.

Several species have been considered with this group that do not properly belong there. These are *vinetorum* Fabr., *transversus* Wied., *hortorum* Fabr., and *minutalis* Will. Of these forms the first differs markedly in being of a pronounced rusty or reddish brown color over the entire insect. All but *transversus* differ further, in having the hind femora considerably though not heavily thickened. In all but *minutalis* the lighter bands of the thorax are not of the characteristic ashy gray or cinereus color found in the *albifrons* group. In *hortorum* they are deeply yellow and the whole insect is strongly reddish and yellowish in color with the exception of the black abdominal markings. In this species there is a dark transverse band on the apical half of the wing; it and *transversus* resemble one another in that the entire third abdominal segment in the female is black with the exception of the narrow shining posterior margins common to nearly the whole genus. It will be seen that *vinetorum* resembles *obsoleta* and *aemula* very strongly in coloration. Moreover as *aemula* is one of the less elongate members of its group, the resemblance is heightened. Thus *vinetorum* occupies a more or less intermediate position between the three groups. The species *minutalis*, however, is quite like a very diminutive member of the *albifrons* group. It differs in the more thickened hind femora and the scutellum is not entirely yellow. The matter of the misfit of species in the groups is discussed in more detail in this group, since there are more of such cases.

By far the majority of the North American forms seem to fit quite well in the several groups and these are marked by only one or two prominent, though striking, characters together with others less so. The number of mis-fits is small and it must be kept in mind that a perfect arrangement is hardly possible.

Key to the species of the *albifrons* group.

1. Scutellum decidedly reddish brown in color; hind femora considerably thickened 2
   Scutellum clear yellow to tinged with reddish; hind femora comparatively slender 3

2. Wings with a wide black band on the apical half; pile of front golden yellow ..... *hortorum* Fabr.
   Wings nearly hyaline; pile of face never golden yellow ..... *vinetorum* Fabr.
3. Bands of thorax rather shining, the gray somewhat metallic; legs usually in large part yellow (female never with yellow on the anterior half of third abdominal segment) ..... *transversus* Wied.
   Whole thorax decidedly opaque, never metallic; legs always in considerable part black (female always with yellow markings in the anterior corners of third segment) 4
4. Very small in size, five to seven mm.; scutellum blackish basally, *minutalis* Will.
   Larger, seven to twelve mm.; scutellum wholly yellow 5
5. Two ashy bands on the thorax, a sutural band and a prescutellar band 12
   Only one ashy band on the thorax, a sutural band 6
6. Markings of the second abdominal segment attenuated towards the anterior part 8
   Markings reach the anterior margin of the second abdominal segment in nearly or completely their full width 7
7. Medium black markings of second abdominal segment less than twice as long as wide ..... *fasciatus* Wied.
   Median black markings much slenderer (in part) ..... *atrimanus* Lw.
8. Only one black band on dorsum of thorax ..... *pusillus* Macq.
   Two black bands on the dorsum of the thorax 9
9. Presutural ashy band interrupted medianly ..... *triangularis* G. Tos.
   Presutural ashy band entire 10
10. Black of posterior part of second abdominal segment never extending to lateral margin (male and female) ..... *floreus* n. sp.
    Black of the posterior part extends to the lateral margin 11
11. Posterior band reaches the lateral margin widely, reddish species, not pronouncedly blackish ..... *atrimanus* Lw.
    Posterior band reaches the sides very narrowly; light color of abdomen and scutellum clear yellow; more strongly blackish in color (female, rarely,) ..... *floreus* n. sp.
12. Markings of the second abdominal segment attenuated towards the anterior part 15
    Markings reach the margin of the first abdominal segment in nearly or completely their full width 13
13. Only one black band on the dorsum of the thorax ..... *alhambra* n. sp.
    Two black bands on the dorsum of the thorax 14
14. Median black markings of the second abdominal segment less than twice as long as wide (male, female in part) ..... *cubensis* Macq.
    Markings three to five times as long as wide ..... *albifrons* Wied.
15. No prescutellar ashy band ..... *taenia* Wied.
    A prescutellar ashy band on dorsum of thorax 16
16. The black is only half as wide as the length of the scutellum; hypopygium normal in size (female) ..... *cubensis* Macq.
    The band nearly or fully as wide as the scutellum; markings of the second abdominal segment often obsolescent; hind femora more thickened; hypopygium two to three times normal size; presutural black band of thorax faint to obsolescent ..... *rufiventris* Macq.

Eristalis rufiventris Macq.

(Plate I, Fig. 4).

Male and Female. Antennæ and arista light brown; facial stripe and ground color of face light reddish brown; cheeks black, in one specimen dark reddish brown. The gray of the thorax is tinged with brown. The presutural black band is very narrow to obsolescent. The post sutural black band is about as wide as the post-sutural gray band. The black

attenuated markings of the second abdominal segment are often obsolescent (faintly indicated), and usually take the shape of a triangle. In one specimen it takes the form of a median unattenuated band. In another all that remains is a small reddish spot. Markings of the third and fourth segment not different from those characteristic for the *albifrons* group save that they may be obsolescent. Femora shining black; apices of femora together with greater part of tibiæ reddish. Hypopygium two or three times the normal size. Length 8–9 mm.

The species is thus characterized by its more strongly reddish coloration, much larger hypopygium, different arrangement of the bands, etc. It most resembles *cubensis*. Besides differing in the above mentioned characters, the presutural black band is much narrower (than in *cubensis*), and the postsutural gray band much wider than (the same band) in *cubensis*. The hind femora are slightly more thickened.

Five females and four males, San Pedro, Honduras; Los Amates, Guatemala; Corumba, Brazil. (O. S. U. coll.).

Eristalis fasciatus Wied.

(Plate I, Fig. 6; Plate II, Fig. 15).

Male and Female. Antennæ dark reddish brown; facial stripe and cheeks shining black, in one or two specimens dark reddish. Ground color of face dark or blackish. Pile of face, light, of front and vertex dark. Thoracic dorsum almost entirely black; a single narrow, presutural ashy band (the region between and in front of humeri is also ashy). Scutellum yellow. Black band of second abdominal segment wide, nearly half as wide as long, unattenuated in the male, rarely in the female; frequently runs to the lateral margin posteriorly. Third segment not differing from the typical form except that the black is often of greater extent. Legs wholly shining black though tarsi sometimes in part light colored. Length, 10 to 12 mm.

The species is an unusually dark form; it is a trifle larger in size. The hind femora, like *rufiventris*, are decidedly thicker than normal. Its nearest allies are *triangularis*, *floreus* and *atrimanus*. The former has the ashy band of the thorax broadly interrupted; the last two differ in the color of the legs, antennæ and the configuration of the black on the second abdominal segment. Specimens have been studied from Bartica, B. Guiana; Los Amates, Guatemala, and Caura Val., Venezuela.

Eristalis triangularis Giglio Tos.

(Plate II, Fig. 19).

Female. Antennæ light reddish brown; facial stripe and ground color of face yellowish brown; cheeks black. Pile of front and face light in color, chiefly black just above the antennæ and on the vertex. Dorsum of thorax largely black; a slender, presutural, ashy band, interrupted medianly for about a third of its width. Scutellum yellow. Black of second segment of abdomen a rather well defined triangle, its base on the posterior margin, reaching to the lateral margin, its two other faces somewhat concave; apex usually reaching the anterior margin. Third and fourth segments similar, the black greater in extent. The light color of the abdomen decidedly reddish. Wholly opaque save for two small spots in the middle of the fourth segment, and a narrowly interrupted transverse band in the middle of the fifth segment. Femora, except tips, distal two-thirds of hind tibiæ, shining black. Tarsi blackish, otherwise legs light yellowish brown. Length, 8 to 11 mm.

Only known from the female. Five specimens. Los Amates, Gualan, Mazatenango, Guatemala; one specimen from Cuba seems to belong here. (O. S. U. collection). Resembles *atrimanus* most, perhaps, but distinct in the interrupted ashy band of the thorax, the more distinct triangles of the abdomen, etc.

This seems to be the species discussed by Williston as "sp. no. 14" (Biol. Cent. Amer.). While I have said "only known from the female," Williston's notes imply that he had the male likewise, and further that it agrees with the female in the widely interrupted band of the thorax.

Eristalis albifrons Wied.

(Plate I, Fig. 7).

Male. Antennæ light yellowish brown to dark reddish brown and facial stripe of nearly the same color. Ground color of face light. Cheeks black. Pile of face and front white (slightly darker upon the vertex). Thorax black, a very narrow gray band just before the scutellum, a still narrower black band between it and the scutellum, and a similar, wider, gray band before the suture, the latter a trifle less wide than the intervening black band. The prescutellar band is wanting in two specimens but these show traces of such. Scutellum yellow, slightly reddish. The markings of the second abdominal segment consist of a quite narrow median band or stripe of black, always meeting the anterior margin, rarely obsolescent posteriorly, about four or five times as long as wide. The black of third segment a posterior marginal band, produced medianly to meet the band of the second segment, always interrupted by the narrow yellow posterior margin of that segment. Thus the yellow

of the second and third segments is confluent in its whole width. Fourth segment entirely black. All the segments opaque save for an interrupted shining band on the fourth segment. Legs largely shining black; apices of femora and larger part of tibiæ, and tarsi, light to dark reddish brown.

Female. Differs chiefly in having the median black stripe of the second abdominal segment dilated gradually very slightly, posteriorly; never more than twice as broad posteriotly as anteriorly. Black of following segments usually of greater extent. Sometimes reddish spots in the anterior corners of fourth segment. Pile of vertex interspersed with black. Length, 10–11 mm.

Quite distinct in the very narrow, unattenuated, median band of the abdomen. Nearest to *cubensis*. The latter has the bands of the abdomen only about one-half as wide as long, or wider, often extended laterally to the sides of the second segment, the yellow of the second segment slightly greater in extent, the prescutellar band not quite so wide, etc. The gray of the thorax is wholly without any tinge of brown or yellow. Several specimens have the abdomen peculiarly whitish; in the majority it is deep yellow and even tinged with reddish. One of the two or three species in the group with any appreciable sexual dimorphism. Material studied is from San Jose, Guatemala; Cameron, La.; Lakeland, Fla., and Yucatan, Mexico.

Eristalis pusillus Macq.

(Plate I, Fig. 2; Plate II, Fig. 17).

Male and Female. Antennæ light reddish brown; facial stripe of nearly the same color. Ground color of face light. Cheeks black, sometimes dark reddish brown. Pile of face and front pale yellowish, in the female with considerable, in the male with slight black pile on the vertex. Thorax black, with the exception of the entire area before the suture, which is ashy gray and slightly tinged with yellow. Thus the black and ashy bands are of nearly equal width. Scutellum yellow. Black of the second abdominal segment a triangle, its base on the posterior margin, which may or may not be extended laterally to the sides, rarely failing to meet the anterior margin. A median black spot on the third segment, sometimes likewise a triangle. Legs largely shining black, narrow apices of femora, base of hind tibiæ, greater part of front and middle tibiæ reddish brown. Length, 8 to 11 mm.

Quite unique in having the thorax marked with two wide bands of black and gray respectively. Nearest to *alhambra*, but in that form there is a comparatively wide, gray, pre-

scutellar band in addition to the anterior band; the black of the second segment a wide, unattenuated stripe, etc.

Specimens have been studied from Los Amates and Gualan, Guatemala; Boniato, Cuba; San Angelo, Brownwood, Roosevelt, Harlingen, Texas; Mexico.

Eristalis atrimanus Lw.

Male. Antennæ, facial stripe, cheeks and ground color of face black. Pile of face silvery white. Pile of front and vertex white interspersed with a little black. Dorsum of thorax black, a rather narrow, uninterrupted, presutural ashy band. Scutellum deep yellow tinged with reddish. The black of second abdominal segment extends forward to the anterior margin in the form of a slightly attenuated median stripe, basally extending to the lateral margins, thus forming an inverted "T." On the third segment the black is in the form of a rather wide (one-third the width of the segment) median band that reaches the anterior margin and extends narrowly, basally, to the sides. Fourth segment entirely black. Femora, except narrow apices, narrow bases of middle and hind tibiæ and basal half of front tibiæ, shining black; remainder rather light brownish yellow.

One specimen, female, Kingston, Jamaica; collection Boston Soc. Nat. Hist. One male, Boniato, Cuba, collection Ohio State University.

The female specimen is certainly this species, but differs in one or two particulars. The antennæ are reddish brown and the facial stripe very dark reddish. The pile of face and front is pale yellowish rather than silvery. Thorax the same as in the male. The black of the second segment agrees except that it is in the form of a triangle, the apex not quite reaching the anterior margin, the two anterior sides slightly concave. Third segment as in the male. On the fourth segment are very small yellow spots in the anterior corners. The legs are considerably lighter in color. Length, 12 mm.

Although only two specimens have been studied, the species seems easily distinguishable by the possession of a single, narrow, presutural ashy band; the black of the second segment reaches the sides of the segment posteriorly, etc. This latter character separates it from *floreus* and *fasciatus*. Further, *floreus* has the scutellum and the light color of the abdomen, clear, light yellow; in *atrimanus* it is deep yellow and slightly tinged with reddish.

Eristalis taenia Wied.

Female. Antennæ dark reddish brown. Facial stripe and ground color of face light brownish yellow. Cheeks reddish brown. Pile of lower front light, of upper part black; pile of vertex light. Thorax black, the whole area before the suture ashy, except for a quite narrow black band that is obsolescent on either side. Black of second abdominal segment a triangle, its apex reaching the anterior margin, not reaching the sides posteriorly but with a small black spot in the posterior corners. Third segment similar but with a black band the whole length of the lateral margin on either side. Fourth segment entirely black. Greater part of the legs light yellowish brown; basal half of the femora, hind tibiæ slightly, and distal joints of tarsi dark brown. The gray of the thorax slightly tinged with brown. Length, 11 mm.

One female. Sao Paulo, Brazil.

Closest, perhaps, to *pusillus*, from which it is distinguished by the prescutellar black band, the lighter colored legs, etc.

Eristalis cubensis Macq.

(Plate I, Fig. 1; Plate II, Fig. 14).

Male and Female. Antennæ a light reddish brown. Facial stripe light to dark reddish brown, cheeks black. Ground color of the face brown, pile light in color; pile of front and vertex inter-mixed with black. Thorax black, a narrow gray prescutellar band and another gray presutural band of about the same width. Scutellum deep yellow, often tinged with reddish. Black of second abdominal segment a rather wide, median, unattenuated band, about twice as long as wide, slightly dilated posteriorly; black of third segment a round median spot continuous posteriorly with a marginal spot or band, that usually runs narrowly to the posterior margin. Fourth segment wholly black, rarely with small light spots in the anterior corners. The female differs in having the black posterior marginal band of the second segment extended to the sides, and a greater proportion of yellow on the remaining segments. Legs largely shining black; bases of hind tibiæ narrowly, of front and middle tibiæ more widely, yellowish. Length, 10–11 mm.

Nearest to *E. albifrons*, with which it has been confused. Distinct in the wide median band of the second segment of the abdomen; further, this band usually extends to the sides posteriorly, in the female of *cubensis*, rarely in the female of *albifrons*. The two black bands of the thorax distinguish it from *alhambra*.

Material studied is from Los Amates, Santa Luchia, Guatemala; San Pedro, Honduras; Port Antonio, Jamaica; Tupelo, Oxford, Miss.

Eristalis alhambra n. sp.

(Plate II, Fig. 10).

Male. Antennæ reddish brown, facial stripe black, ground color of face dark brownish; in one specimen the facial stripe is rather light brown and the ground color likewise light. Pile of face silvery white. Pile of front and vertex light, of upper part of front black. Cheeks black. Thorax black, the whole area before the suture ashy gray and a second ashy band before the scutellum. The black band is thus comparatively limited in extent; it is about the same width as the prescutellar gray band. It is the only black thoracic band in as much as the extremely narrow black border just in front of the scutellum is scarcely noticeable or lacking.

Gray of thorax untinged with yellowish. Scutellum clear yellow. Black of second abdominal segment a wide median band, always attaining the anterior margin, slightly dilated posteriorly but never reaching the lateral margins. Black of third segment a similar band of nearly the same width, produced posteriorly to the sides. Fourth segment nearly all black; narrow yellow spots in the anterior corners. Legs not differing greatly in coloration from the other members of the group; hind femora a trifle more thickened, resembling *rufiventris* and *fasciata* in this respect.

Female. The female differs chiefly in that the black of second abdominal segment is wider and is extended to the lateral margin posteriorly, leaving the yellow in the form of two round spots. Black of third segment considerably greater in extent. Fourth segment wholly black. Length, 8–9 mm.

Closest to *E. pusillus*, but this species has only one ashy band on the thorax.

Holotype male, paratype male and allotype female. Collection of Mr. W. M. Davidson, Alhambrae, Calif. Paratype male and two females, Mills Creek Canyon and Redlands, Calif. (F. R. Cole collection).

Eristalis floreus n. sp.

(Plate I, Fig. 3).

Male. Antennæ light reddish brown; facial stripe reddish, in one specimen black; cheeks black. Pile of face pale yellowish white, ground color light; pile of front and vertex light, inter-mixed with black. Thorax black, a comparatively narrow ashy band, tinged faintly with yellowish, just before the suture. Scutellum clear yellow. Black of second abdominal segment a slightly acute triangle; its base on the posterior margin, not reaching the sides; its apex reaching the anterior margin. Third segment with a round black median spot on the anterior half, continuous posteriorly with a black band on the margin, the latter

reaching the sides of the segment. Fourth segment wholly black. Legs shining black, narrow apices of femora, base of hind tibiæ narrowly, of front and middle tibiæ more widely, yellowish.

Female. The female differs in the black of the second segment being narrowly extended posteriorly, to the lateral margin. In this respect it comes very close to *E. atrimanus*, which has the black reaching the lateral margin much more widely. *E. atrimanus* is a reddish yellow form, with the scutellum tinged with reddish. The lighter color of floreus is a clear, light yellow. As the male seems quite different, I have considered the two forms distinct. The species *floreus* really resembles *fasciata* more closely; like that species it is of a pronounced blackish color, but is readily separated by the attenuated spots of the second abdominal segment, the less thickened femora, etc. Length, 10–11 mm.

Holotype and paratype male and allotype female, Bartica and Kartabo, British Guiana, (collection O. S. U.). Paratype male, (collection of writer).

Eristalis vinetorum Fabr.

(Plate I, Fig. 9).

Male. The antennæ, facial stripe and general color of face light reddish brown. Cheeks reddish brown. Pile of face, front and vertex, pale yellowish white, immediately around the ocelli, black. Thorax gray, with a slight brownish tinge; a wide black band behind the suture, and a similar band of about half the width of the former, before the suture. The prescutellar band is somewhat convex on its posterior margin. Thorax usually feebly shining on the posterior half. Scutellum reddish brown, darker in the center and basally. Black of second abdominal segment opaque, a narrow median stripe somewhat dilated anteriorly and meeting the anterior margin, extended posteriorly in a dark marginal band to the sides of the segment. Second segment otherwise shining, reddish brown or fulvous. Third segment with a round black spot medianly on the anterior half, continuous posteriorly with an opaque black marginal band, reaching the sides; otherwise shining reddish brown. Fourth segment with narrow marginal, opaque black bands anteriorly and posteriorly, and between, a wide metallic greenish or black band. Segments with the usual narrow yellow bands on the posterior margins. Pile of whole thoracic dorsum, and of abdomen except on the black areas where it is black, short, abundant, brownish yellow to fulvous. Legs shining reddish to yellowish, darker on the femora, sometimes black on the hind femora. Pile light yellow. Hind tibiæ considerably thickened and somewhat arcuated. A row of strong, short, black bristles, above and below. Hind femora considerably thickened. Wings slightly infuscated about the middle on the anterior half.

Female. Usually with a greater degree of black on the abdomen; frequently the yellow areas of the third and fourth segments are wholly shining black. Length, 11–14 mm.

Very different in its reddish brown or fulvous coloration, in which it approaches quite closely *E. obsoleta*, differing in the fasciate thorax, etc. Besides differing from the other members of the group as above mentioned, the abdomen is in a very large degree shining; the typical species are almost wholly opaque. Recorded from numerous Southern States, as well as Ind., Mex., Cuba and Brazil.

Eristalis transversus Wied.

(Plate I, Fig. 5).

Male. Antennæ dark reddish brown, arista slightly plumose basally; cheeks and facial stripe shining black; pile of face and occiput white, of front, and vertex near the ocelli, black; ground color of face black. Thorax black, the whole area in front of the suture brownish gray, somewhat shining; a rather wide band, with opaque black on either side, behind the suture, considerably shining. Scutellum yellow. Pile of whole thorax yellowish. First segment of abdomen black; second with a widely obtuse black triangle, its base on the anterior margin and extended in a median band to meet the black posterior, marginal band, the posterior marginal band extending to the sides; two large yellow triangles or spots are thus left on either side of the second segment.

Third segment yellow, with a black posterior marginal band, and a median, characteristically rectangular spot, continuous with the band but not reaching the anterior margin. Fourth segment entirely black. Abdomen opaque, a shining cross band on the third and fourth segments. Legs black, the narrow apices of the femora, base of hind tibiæ, front and middle tibiæ except apices, and greater part of front and middle tarsi, yellow. Wings nearly hyaline.

Female. Differing markedly in having the third segment wholly black, save for the customary posterior marginal bands. Front and middle femora, and basal half of hind femora usually, likewise yellowish. Length, 7–12 mm.

A characteristic, well known species differing from the typical members of the group in the points mentioned under the group description. It further departs from this type in the shining, even sometimes metallic, bands of the thorax, plumose arista, etc.

Widely distributed over the Eastern half of the country, Canada to Florida, and West to Texas.

Eristalis hortorum Fabr.

(Plate I, Fig. 8).

Male. Antennæ deep yellow; facial stripe and ground color of face light yellowish or reddish brown; cheeks black. Pile of face and front,

as well as vertex and occiput, golden, black around the ocelli. Thorax black, rather shining posteriorly; a narrow band before the scutellum, a second band before the suture and the region below and between the humeri, deeply yellow, tinged with brownish. Scutellum brownish red. Pile of thorax almost wholly deep yellow, black on the pteropleura. Black of second abdominal segment similar in pattern to that of *transversus;* sidespots shining brownish red. Third segment black, reddish spots in the anterior corners; a narrow opaque black band both anteriorly and posteriorly. Fourth segment black, likewise with narrow opaque margins. Legs wholly deep shining red, more orange to yellow on the front and middle pairs. Hind femora considerably thickened. Wings with a dark brown band on outer anterior half, yellowish on basal half, hyaline posteriorly. Length, 12 mm.

Female. As in *transversus* the female has the third abdominal segment wholly without light spots in the anterior corners.

One male and one female, San Juan and Aibonito, Porto Rico; recorded by Will. from San Domingo.

Eristalis minutalis Will.

Female. Antennæ reddish brown; facial stripe dark reddish, nearly black; ground color face similar; cheeks black. Pile of face, front and occiput light, on the vertex dark. Thorax opaque gray, a rather wide band just behind the suture, a second band about half the size of the first before the suture, and the narrow posterior marginal band of the thorax, black. Scutellum yellow, blackish basally. Second abdominal segment black save for a round yellow spot on each side, not reaching the lateral margin and surrounded by black on all sides. Third segment black, with yellow spots in the anterior corners, reaching the margin. Fourth segment similar, yellow spots very small. Legs not differing greatly from the other members of the group except that the hind femora are somewhat thickened. Length, 6–8 mm.

Williston records both male and female of this species and remarks that the scutellum seems variable in the amount of black.

Quite apart from the other species in its diminutive size, thickened femora, etc.

One female, San Pedro, Honduras, (O. S. U. coll.); one male, Kartabo, British Guiana, (coll. C. H. Curran). The male, which apparently belongs here, has the scutellum wholly yellow.

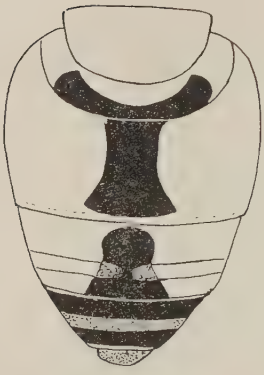
EXPLANATION OF PLATES.

Plate I.

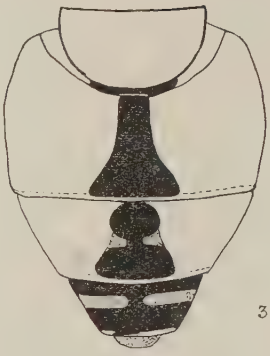
Abdomens of *Eristalis; albifrons* group. On the drawings black represents opaque black; heavily stippled areas represent shining black, and lightly stippled areas depict brown. Uncolored areas show yellow or red. Drawings by camera lucida. Slight differences in shapes of abdomens should not be considered seriously as they are likely to be due to shrinkage or drying.

Plate II.

Drawings of *Eristalis; albifrons* and *furcatus* groups. Figures ten to thirteen represent abdomens, Figures fourteen to twenty-one the thorax, and Figure twenty-two, a lateral view of the head.

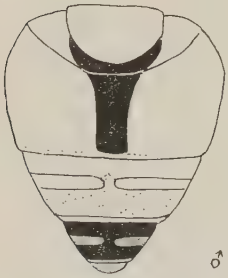


1 .cubensis ♂



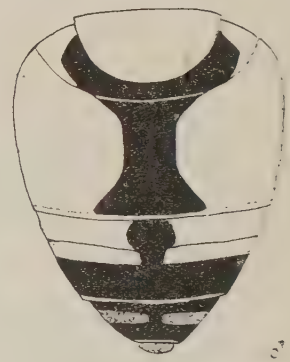
2 . pusillus ♂

3 .floreus ♂



4 .rufiventris ♂

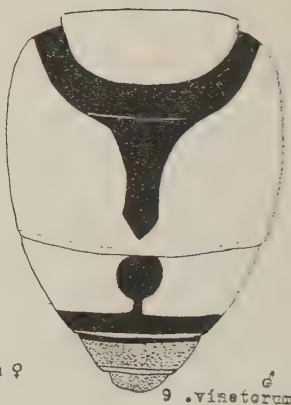
5 .transversus ♀



6 .fasciata ♂

7 .albifrons ♂

8 .hortorum ♀



9 .vinetorum ♂

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10. alhambrae ♂
11. furcatus ♂
12. quadraticornis ♂
14. cubensis ♂
15. fasciatus ♂
18. quadraticornis ♀
13. philippi ♂
16. philippii ♂
20. furcatus ♂
21. texanus ♀
19. triangularis ♀
17. pusillus ♂
22. quadraticornis ♂

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FOUR UNDESCRIBED SPECIES OF WATERSTRIDERS (HEMIP.-GERRIDÆ).

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This paper contains the descriptions of four new species of waterstriders of the family Gerridæ. Of these, two are known only from Colorado, one from Colorado, Utah, Iowa and Oregon, and the other ranges from Colorado to Maine. Dr. H. B. Hungerford and Dr. Herbert Osborn have kindly permitted the writers to study the specimens of Gerridæ in the collections of the University of Kansas and the Ohio State University.

Gerris (*Limnoporous*) *notablis*, n. sp.

Very closely related to *G. rufoscutellatus* Latr. but separated from it by its much larger size, longer legs, the more prominent carina of the pronotum, and the difference in the proportional lengths of the antennal segments. In *rufoscutellatus* the posterior margin of the sixth segment is more truncate and widely excavated and the apical spines do not usually reach the end of the second genital segment; in *notabilis* the last dorsal segment and connexivum of the abdomen are more roundly excavated and the apical spines are stouter, longer, and generally reach to the tip, or a little beyond the tip of the last genital segment. Length, male, 15–16 mm.; female, 15.5–16.1 mm.; width, male, 2.2 mm.; female, 2–2.32 mm.

Very elongate, moderately robust, rufescent or ferrugineous; head, a large spot on each side of the pronotum in front, sides of pronotum and nervures of hemelytra blackish brown; body beneath densely clothed with long silvery hair. Antennæ brown at the base, growing blackish brown towards the tips; first segment considerably longer than any of the others, second segment much shorter than the first and longer than third or fourth, the fourth a little shorter than the second and a little longer than the third; other characters about the same as in *rufoscutellatus*.

Male: The intermediate and posterior legs much longer than in *rufoscutellatus*, the posterior margin of the first genital segment beneath nearly truncate; antennæ longer than in the female.

Female: Very similar to the female of *rufoscutellatus*, but larger, with longer legs; the connexivum terminating in a stouter and longer spine.

Holotype, macropterous male, *allotype*, macropterous female, taken on a small pond, elevation 9,300 feet, Pingree Park, Colorado, August 18, 1924, by the authors, in the collection of C. J. Drake. *Paratypes:* Pingree Park, Colorado, August, 1924, by Dr. P. B. Lawson and Prof. R. H. Beamer, and by the authors, August 18 to 24, 1924; Estes Park, Colorado, August 27, 1924, by the authors; Corvallis, Oregon, June 1, 1899; Ames, Iowa, July 24, 1924, by C. J. Drake; Emery County, Utah, July 30, 1922, and September 13, 1921, by Mrs. Grace Wiley.

This species ranges from Oregon to Iowa and inhabits ponds and lakes. It is very closely related to *Gerris rufoscutellatus* Latr.; on account of its antennal and genital characters and much longer legs, it seems best to consider *notablis* a distinct species rather than a variety of *rufoscutellatus*.

G. notablis, n. sp., was taken in company with *G. pingreensis*, n. sp., at Pingree Park and Estes Park, Colorado; with *G. comatus*, n. sp., *G. buenoi* Kirk., *G. marginatus* Say, *G. rufoscutellatus* Latr., *G. remigis* Say, *Trepobates pictus* H. S., *Metrobates hesperus* Uhl., *Rheumatobates rileyi* Bergr., *Mesovelia mulsanti* White, *Microvelia borealis* Bueno, and *Merragata foveata* Drake, at Ames, Iowa.

Gerris (Aquarius) nyctalis, n. sp.

Differs from *G. remigis* Say by its darker color and shorter body, legs and antennæ, especially the first segment. Length, male, 11.9–12.4 mm.; female, 11.5–13 mm.; width, 2.6–3.2 mm.

Apterous form: Pronotum blackish, sparsely pubescent, with the posterior margin broadly rounded, the median carina distinct, the median anterior stripe yellowish brown. Antennæ moderately long, blackish; first segment distinctly shorter than in *remigis*, twice the length of the second, the second very slightly longer than the third and the fourth a little longer than the second. Abdomen above blackish, the pubescence sparse and extremely short, each of the last four segments usually with a longitudinal, discal, bluish gray streak; connexivum broad, with a very small, brownish spot along the outer margins between each segment; terminating in a broad, stout, moderately long spine, the tip of which projects slightly inwardly and upwardly. Legs moderately long, blackish above, the tips of intermediate and hind femora extending a little beyond the tip of the abdomen. Body beneath brownish black, prosternum, coxæ and part of trochanters yellowish or brownish.

Male: Venter broadly flattened; sixth segment distinctly depressed in the middle, the posterior margin raised and very deeply, broadly and roundly notched, fringed with rather long, yellowish hairs. Genital segments blackish, the first segment with the median ridge narrower than in *remigis*.

Female: Venter distinctly broader than in remigis; genital segments blackish; pronotum very broadly rounded posteriorly.

Macropterous form: Pronotum with anterior lobe depressed, especially in the middle; humeri large and prominent; posterior margin not so broadly rounded as in the apterous form. Hemelytra reaching almost to tip of first genital segment, the nervures brownish black and sparsely pubescent.

Holotype, apterous male, and *allotype*, apterous female, taken in U. S. National Park, near Estes Park, Colo., August 27, 1924, by the authors, in collection of Carl J. Drake. *Morphotype*, macropterous female, collected with holotype. *Paratypes* and *morphotypes* collected with holotype in collections of Iowa State College, Colorado Agricultural College, and the authors. This species was collected about nine miles from Estes Park, on a small beaver pond along the Bear Lake road. It was taken in company with *G. pingreensis*, n. sp. and *G. comatus*, n. sp.

Gerris (Gerris) comatus, n. sp.

Size and general aspect very similar to *G. marginatus* Say and *G. alacris* Hussey; male readily distinguished from either of these by the two prominent tufts of long hair, one on each side of the first ventral genital segment; the omphalium of the metasternum is prominent, but not as large or as prominent as in *alacris*. The female is rather hard to distinguish from the female of *marginatus*, but the first genital segment above is a little broader, and the terminal spine of the connexivum is a little more blunt, the tips of the spines usually darker and clothed with longer hairs. Length, male, 7.3–8.2 mm.; female, 8–8.9 mm.; width, male, 2.3–2.5 mm.; female, 2.6–2.8 mm.

General color of body, legs and antennæ very similar to *G. marginatus;* in the macropterous form hemelytra slightly variable in length and either reach almost to, or more or less cover the first genital segment. The hemelytra in the brachypterous form do not completely cover the fifth abdominal segment. The apterous form is unknown. The proportional lengths of the antennal segments are almost identical with *marginatus*.

Male: The sixth dorsal segment deeply, broadly and roundly emarginated, terminating in very short spines. Venter indistinctly carinate, the third, fourth, fifth and sixth segments somewhat depressed; sixth segment deeply and roundly excavated. First genital segment with the sides deeply depressed and with a prominent tuft of long hair in each depression.

Female: Very closely allied to the female of *marginatus*, the terminal spines of the sixth segment slightly shorter, a little more blunt and clothed with longer hair; first genital segment above slightly shorter and broader than in *marginatus*.

Holotype, macropterous male, and *allotype*, macropterous female, taken on small pond, Y. M. C. A. Conference grounds, Estes Park, Colorado, August 27, 1924, by C. J. Drake and F. C. Hottes. *Morphotypes;* male, taken on Sandusky Bay,

Cedar Point, Ohio, July, 1912, by C. J. Drake, and female, from Mirror Lake, O. S. U. Campus, Columbus, Ohio, Sept. 10, 1913, by C. J. Drake. Many *paratypes* and *paramorphotypes* from U. S. National Forest, Estes Park, Colorado, August 27, 1924, by the authors; Ames, Iowa, July 24, 1924, by C. J. Drake, H. M. Harris and F. C. Hottes; Ames, Iowa, October 18, 1924, by authors; Colorado, long winged male No. 2021; Buckeye Lake, Ohio, June 20, 1916, and June 30, 1916, by C. J. Drake; Sandusky, Ohio, July, 1912, by C. J. Drake; Columbus, Ohio, September 19, 1913, by C. J. Drake; Rice Lake, Wisconsin, August 28, 1912, by A. C. Burrill, collected sweeping; Bar Harbor, Maine, July 29, 1916, by Herbert Osborn.

Paratypes in the collections of Iowa State College, Colorado Agricultural College, Ohio State University, H. M. Harris and the authors. *Paramorphotypes* in the collection of the authors.

This species has been confused in collections with *G. marginatus* Say. The males are very distinct and not easily confused with *marginatus* or other allied forms.

Gerris (Gerris) pingreensis, n. sp.

Allied to *G. buenoi* Kirk. and with similar color markings on the pronotum, but readily separated from it by the shorter basal segment of the antennæ, the distinct median carina of the pronotum and the much differently formed sixth ventral and genital segments of the male. Length, male, 9–9.85 mm., female, 9–10 mm.; width, male, 2–2.2 mm., female, 2.1–2.5 mm.

Antennæ moderately long, brownish black; first segment a little longer than the fourth and subequal to the second and third conjoined; third segment slightly shorter than the second. Legs moderately long, blackish above and brownish beneath. Pronotum broader, more deeply pitted and more roughened than in *G. buenoi*, the posterior margin very broadly rounded; sparsely clothed with extremely short, golden pubescence; anterior lobe with the short discal and the marginal stripes brownish; body beneath blackish, with rather short, silvery hairs; genital segments brownish or brownish black. Rostrum reaching to the mesosternum, the apical segment smooth and blackish.

Macropterous form: Humeri prominent, the margin beneath brownish. Hemelytra not completely covering the genital segments; nervures blackish brown, the pubescence sparse and extremely short.

Apterous form: Pronotum much more flattened, and the carina more prominent than in winged specimens; anterior lobe strongly depressed on each side of median line; posterior margin very broadly rounded and slightly carinate.

Male: Venter broadly, concavely depressed, with a median, longitudinal carina; sixth segment with the deep, broad furrow becoming wider and deeper posteriorly, as deeply but not as widely notched as *buenoi*. Genital segments and ventral projection of first segment narrower than in *buenoi*. Connexivum terminating in a broad and very short spine.

Female: Venter somewhat flattened; in the apterous female, first abdominal segment above with a prominent tubercle. Connexivum terminating in a broad, moderately long, upwardly projecting spine, the tip of which is black.

Holotype, macropterous male, and *allotype*, macropterous female, taken on a small pond, elevation 9,300 ft., Pingree Park, Colorado, August 18, 1924, by the authors, in the collection of Carl J. Drake. *Morphotypes*, apterous male and female, collected with types. Several hundred *paratypes* and *paramorphotypes:* Pingree Park, August 16–23, 1924, by the authors; Pingree Park, August 18–23, 1924, by Doctor P. B. Lawson and Professor R. H. Beamer; Estes Park, and U. S. National Forest near Estes Park, August 27, 1924, by the authors. *Paratypes* and *paramorphotypes* in the collections of Iowa State College, Kansas State University, Colorado Agricultural College, Ohio State University, U. S. National Museum, and the authors. This species is very abundant on ponds and small lakes in high altitudes. It was taken in company with *G. nyctalis*, n. sp. and *Gerris* sp. at Pingree Park, and with *G. nyctalis*, n. sp. and *G. comatus*, n. sp. in Estes Park and in the U. S. National Forest.

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